PREVENTION OF DETERIORATION CENTER

DIVISION OF CHEMISTRY AND CHEMICAL TECHNOLOGY

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EFFECTS OF STORAGE ON

ELECTRONIC EQUIPMENT AND COMPONENTS,

A PRELIMINARY LITERATURE SURVEY

Compiled by

Richard W. H. Lee



Lecember 6, 1962

2101 Constitution Avenue Washington 25, D. C.

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- AN-76
 Signal Corps. Fort Monmouth, N.J. Ground Signal Agency.
 Components and Materials Test Section (C.P. Lascaro, J.A.
 Beaver, C.L. Semmelman and A.W. Rogers).

 Summary of moisture resistance tests. November 1944. 12 p.
- A-834
 U.S. Signal Laboratory, Camp Evans, Belmar, N.J. (George A. Doolittle and Beverly D. Kumpfer).

 investigation of magnetron shell life. (Its Technical Memorandum No. M-1234). November 1949. 18 p.
- A-1029
 U.S. Signal Laboratory, Fort Mommouth, N.J. Components and Materials Branch. Performance Test Section (John S. Aravosis). Correlation studies of modsture resistance tests. (U.S. Signal Laboratory, Fort Monmouth, N.J. Technical Memorandum M-1312). July 1950.
- C-1457 Eell Telephone Laboratories, Inc. Laboratory, Whippany, N.J.

 (D.A. Alsberg, et. al.).

 Engineering services on transistors. (U.S. Signal Corps. Contract DA-36-039-SC-5589, Eleventh Interim Technical Report;
 ... [ASTIA Document] AD 37212). 1954. 98 p.
- C-1545 Cook Electric Company, Chicago, Ill. Inland Testing Laboratories).

 Life testing of tantalum electrolytic capacitors. (Its
 Test Report No. 2118A; ... [ASTIA Document] AD 59890).
 February 1955. 29 p.
- G-778(43) Battelle Memorial Institute, Columbus, Ohio (A.R. Close, H.C. Palmer, W.C. Ellis and M.M. Baldwin).

 Tropicalization of radio and radar equipment. (U.S. Air Materiel Command. Contract AF 33(038)-450, Final Report).

 November 1949. 121 p.
- G-3360 Wells, George C.

 Dehumidification protects materials from deterioration. Tests indicate value of controlled humidity. In Heating, Piping Air Conditioning 20(8):75-80. August 1948.
- G-3896(13) Battelle Memorial Institute, Columbus, Ohio (D.B.J. Bridges, W.T. Sackett, Jr. and J.H. Graham).
 Evaluating, rating, and filing data on electronic components; a study of the prediction of composition-resistor life.

 (Its Thirteenth Interim Engineering Report; U.S. Air Materiel Command. Contract No. AF 33(038)-1229, December 28, 1950 to September 30, 1951; U.S. Armed Services Technical Information Agency. Air Technical Index No. 126051). December 1951. 88 p.

G-3896(13A) Battelle Memorial Institute, Columbus, Ohio (D.B.J. Bridges, W.T. Sackett, Jr., and J.H. Graham).

Fvalueting, rating, and filing data on electronic components; a study of the prediction of predried composition-resistor life. (Its Supplement to the thirteenth interim engineering report; U.S. Dept. of the Air Force. Contract No. AF 33(038)-1229, Sept. 30, 1951 to Feb. 29, 1952; U.S. Armed Services Technical Information Agency. Air Technical Index No. 155800). May 1952. 29 p.

G-10484(1) Minnesota. University. Dept. of Mechanical Engineering (C.E. Lund and M.L. Erickson).

Evaluation of U.S. navy dehumidified warehouse program. Part 1. (Its Progress Report No. 3; U.S. Bureau of Yards and Docks. Contract MOy 79585). September 1954. 132 p.

G-10487 Minnesota, University, Dept. of Mechanical Engineering (C.E. Lund and M.L. Erickson).

Summary of technical literature survey on dehumidification and dehumidified storage. (Its Progress Report No. 2; U.S. Bureau of Yards and Docks. Construct NOy 79585). June 1954. 80 p.

G-12607 Battelle Memorial Institute, Columbus, Ohio (K.E. Cochran, D.F. Edwards, N.B. Crane, S.A. Woodruff and C.F. Salt).

Laboratory test procedures for predicting the tropical service life of electronic components and materials. (U.S. Signal Corps. Contract DA-36-039-SC-64518, Third Quarterly Progress Report; ... [ASTIA Document] AD 71454). June 1955. 64 p.

G-12702 Battelle Memorial Institute, Columbus, Ohio (K.E. Cochran, N.B. Crane, S.A. Woodruff, and C.F. Salt).

laboratory test procedures for predicting the tropical service like of electronic components and materials. (U.S. Signal Corps. Contract DA-36-039-SC-64518, First Quarterly Progress Report; ... [ASTIA Document] AD 52175). December 1954. 18 p.

G-12714 Estable Memorial Institute, Columbus, Ohio (K.E. Cochran, N.B. Owne, S.A. Woodruff, and C.F. Salt).

Laboratory test procedures for predicting the tropical service life of electronic components and materials. (U.S. Signal Corps. Contract DA-36-039-30-64518, Second Quarterly Progress Report; ... [ASTIA Document] AD 68219). March 1955. 46 p.

U-13066
Linden, Erik G. (U.S. Signal Laboratories, Fort Mormouth, N.J.).

Weather testing of ence sulating materials. In Electronic

Equipment 4(7):21-27. July 1956. [Originally in Army-Navy-Air Force sponsored Symposium on Casting Resins, Jan. 24-25,
1956; ASTIA Documer in 10048, p. 326-346].

Preservation of military equipment: "Teflon" operational lubricant preservative costing; A marine corps approach to the storage of vehicles and major items; Preservation of electrical equipment. In Corrosion Technol. 3:375-377. November 1956. [Symposium on Preservation of Mobilisation Requirements held at United States Naval Civil Engineering Research and Evaluation Laboratory, Port Russess, California in October].

PDC Search No. 62-053

- G-13365

 Henney, Keith, Ed.

 Moisture and its effect on equipment. In Reliability Factors
 for Ground Electronic Equipment, McGraw Hill, 1956, p. 6-22 6-27.
- G-13374

 Battelle Memorial Institute, Columbus, Ohio (K.E. Hassler, N.B. Crane, and K.E. Cochran).

 Laboratory test procedures for predicting the tropical service life of electronic components and materials. (U.S. Signal Corps. Contract DA-36-039-SC-64518, Fourth Quarterly Progress Report; ... [ASTIA Document] AD 92450). December 1955. 58 p.
- G-13534 Keefer, H.J.

 Dust on relay contacts. In Bell Labs. Record 35:25-28. January
 1957.
- G-13649 Linden, Erik G. (U.S. Signal Laboratory, Fort Monmouth, N.J.). Thermal properties of encapsulatina, materials. (... [ASTIA Document] AD 102048, p. 255-270). [Part of Army-Navy-Air Force sponsored "Symposium on Casting Resins," Jan. 24-25, 1956. Also published in Electronic Equipment 4(7):40-45, July 1956].
- PDL-31253 Vacca, G.N. and C.V. Lundberg (Bell Telephone Laboratories, Murray Hill, N.J.).

 Aging of neoprene in a weatherometer. In Wire end Wire Products 32:418-422,457. April 1957.
- PDL-31512 Battelle Memorial Institute, Columbus, Ohio (K.E. Hassler, N.B. Crane, and K.E. Cochran).

 Laboratory test procedures for predicting the tropical service life of electronic components and materials. (U.S. Signal Corps. Contract DA-36-039-SC-64518, Fifth Quarterly Progress Report). March 1956. 52 p.
- PDL-31513 Pattelle Memorial Institute, Columbus, Ohio (K.E. Hassler, N.B. Crane, and K.E. Cochran).

 Laboratory test procedures for predicting the tropical service life of electronic components and materials. (U.S. Signal Corps. Contract DA-36-039-SC-64518, Sixth Quarterly Progress Report). May 1956. 50 p.
- PDL-31514 Battelle Memorial Institute, Columbus, Ohio (N.B. Crane and K.E. Hassler).

 Leboratory test procedures for predicting the tropical service life of electronic components and materials. (U.S. Signal Corps. Contract DA-36-039-SC-64518, Seventh Quarterly Progress Report). August 1956. 42 p.
- PDL-31515 Ratiable Memorial Institute, Columbus, Ohio (G.P. Chipman, N.B. Crane, A.E. Mace, H.M. Braner, and K.E. Hassler).

 Laboratory test procedures for predicting the tropical service life of electronic components and materials. 'U.S. Signal Corps. Contract DA-36-039-8C-64518, Kighth Quarterly Progress Report). November 1956. 124 p.

- PDL-31516 Battelle Memorial Institute, Columbus, Ohio (G.P. Chipman and K.E. Hassler).
 - Laboratory test procedures for predicting the tropical service life of electronic components and aterials. (U.S. Signal Corps. Contract DA-36-039-8C-64518, Ninth Quarterly Progress Report). February 1957. 22 p.
- PDL-31517 Battelle Memorial Institute, Columbus, Ohio (G.P. Chipman and K.E. Hassler).
 - Laboratory test procedures for predicting the tropical service life of electron c components and materials. (U.S. Signal Corps. Contract DA-36-039-SC-64518, Tenth Quarterly Progress Report). May 1957. 44 p.
- PDL-31518

 Battelle Memorial Institute, Columbus, Chio (G.P. Chipman and K.E. Hassler).

 Laboratory test procedures for predicting the tropical service life of electronic components and materials. (U.S. Signal Corps. Contract DA-36-039-SC-64518, Eleventh Quarterly Progress Report). Augus: 1957. 33 p.
- PDI-31793 Gt. Brit. Ministry of Defence.

 Code of practice for the climate-proofing of electrical equipment.

 (Its [Pamphlet] DEF.-CP.-1). May 1956. 41 p.
- PDL-31801 Garrett, C.G.B.
 Transistors, reliability and surfaces. In Bell Labs. Record
 35:466-470. November 1957.
- PDL-32551 Battelle Memorial Institute, Columbus, Ohio (George P. Chipman and K.E. Hassler).

 Laboratory test proc dures for predicting the tropical service life of electronic components and materials. (U.S. Signal Corps. Contract DA-36-039-SC-64518, Twelfth Quarturly Progress
- PDE-32566

 Battelle Memorial Institute, Columbus, Ohio (George P. Chipman and Kenneth E. Hassler).

 Laboratory test procedures for predicting the tropical service life of electronic components and materials. (U.S. Signal Corps. Contract DA-36-039-SC-64518, Thirteenth Quarterly Progress Report). January 1958. 24 p.

Report). November 1957. 99 p.

- PDL-33315 Battelle Memorial Institute, Columbus, Ohio (J.L. Easterday and K.E. Hasbler).

 Laluratory test procedures for predicting the tropical service
 - life of electronic components and materials. (U.S. Signal Corps. Contract DA-36-039-SC-64518, Fourteenth Quarterly Progress Report). May 1958. 22 p.
- PDL-33650 Bat'elle Memorial Institute, Columbus, Chio (J.L. Easterday, I. Braner and K.E. Hassler).

 Le pratory test procedures for predicting the tropical service life of electronic components and materials. (U.S. Signal Corps. Contract DA-36-039-SC-64518, Fifteenth Quarterly Progress Report). August 1958. 30 p.

- PDI-33761 Vitro Laboratories, Silver Spring, Md.
 Techniques for reliability measurement and prediction based on field failure data. Electronic equipment reliability program. (Its Technical Report 80). October 1955. 89 p.
- PDL-34208 Lupton, H.W. and Leo Lampert.
 Improvement of transistors. In BuShips J. 7(9):33-36. January
 1959.
- PDL-34484

 Battelle Memorial Institute, Columbus, Ohio (J.L. Easterday, P.R. Dennis and K.E. Hassler).

 Laboratory test procedures for predicting the tropical service life of electronic components and materials. (U.S. Signal Corps. Contract DA-36-039-8C-64518, Sixteenth Quarterly Progress Report). November 1958. 46 p.
- PDL-35117 Battelle Memorial Institute, Columbus, Ohio (J.L. Easterday, A.E. Mace, and W.E. Chapin).

 Laboratory test procedures for predicting the tropical service life of electronic components and materials. (U.S. Signal Corps. Contract DA-36-039-SC-64518, Final Summary Report).

 March 1959. 118 p.
- PDL-35179 McMahon, W., H.A. Birdsall, G.R. Johnson and C.T. Camilli (Bell Telephone Laboratories, Inc.).

 Polyester film, how long does it last. In Materials in Design Eng. 49(2):94-95. February 1959.
- PDL-35244 Johns Hopkins University, Baltimore, Md. Institute for Cooperative Research. Dielectrics Laboratory (John J. Chapman and Louis J. Frisco).

 Dielectric materials moisture resistance study. (U.S. Bureau of Ships. Contract NObsr-63251, Final Report; U.S. Office of Technical Services. Publication Board [series] PB 151014; ...

[ASTIA Document] AD 129348). March 1955. 72 p.

- PDI-35565 Protection by humidity control. <u>In</u> Corrosion Technol. 6:206-207. July 1959.
- PDL-35912 Harris, A.P. and E.W. Parrott (Canada. Dept. of National Defence.

 Military Electronics Standards Agency).

 What designers should know about humidity. In Electronics 32(44):
 50-55. October 1959.
- PDL-36406 Walter, Leo.
 Air treatment: The prevention of corrosion in storage. Part 1.
 In Corrosion Technol. 6:327-329. November 1959.
- PDL-36512 Walter, Leo.

 Air treatment: The prevention of corrosion in storage. Part 2.

 In Corrosion Technol. 6:372-373,382. December 1959.
- PDL-37161 Karas, William P. (Stromberg-Carlson, Rochester, N.Y.).
 Reliability analysis of an electronic switching center. In
 Proceedings 1960 Electronic Components Conference. p. 140150. May 1960.

- PDI-37174 Schlabach, T.D. and D.K. Rider.

 Thermal degradation of printed wiring adhesives. In Adhesives

 Age 2:18-22. July 1959. [Bell Telephone System, New York,

 N.Y. Technical Publications. Monograph 3309].
- PDL-37906 Schrader, E.R.

 A study of electron tube deterioration utilizing kinetic theory.

 (Radio Corporation of America. Electron Tube Division,
 Harrison, K.J. Querterly Report 4; ... [ASTIA Document] AD
 239837). 1960. 71 p. [For the period: April 1 July 1,
 1960].
- PDL-38604 U.S. Office of Technical Services.
 Reliability and quality control (1950-1960). (Its Selective Bibliography 405). April 1960. 9 p.
- PDL-38811 Earles, D.R. (Glenn L. Martin Company. Denver Division, Denver, Colo.).

 Reliability growth prediction during the initial design analysis.

 In Proceedings 7th National Symposium Reliability and Quality

 Control. p. 386-393. January 1961.
- PDI-38974 Zablodil, R.J. and J.C. King.
 Warehouse and preservation methods and economics for storing materiel. (U.S. Naval Civil Engineering Laboratory, Port Hueneme, Calif. Technical Report 075; ... PB 149233; ... (ASTIA Document) AD 239745). June 1960. 112 p.
- FDL-39216

 Schrader, E.R.

 A study of electron tube deterioration utilizing kinetic theory.

 (Radio Corporation of America. Electron Tube Division,

 Harrison, N.J. Quarterly Report 5; ... [ASTIA Document] AD

 244619) [n.d.]. 86 p. [For the period: July 1 October 1,
 1960].
- PDL-39297 Klein, M. and L. Rosenberg (Columbia University, New York, N.Y.).
 Deterioration of inventory and equipment. <u>In Naval Research</u>
 Logistics Qtly. 7(1):49-62. March 1960.
- PDI-3%03 Bartholomew, C.Y. (Bell Telephone Laboratories, Allentown, Pa.). Impurities introduced into Kover Envelope electron tubes by atmospheric corrosion. In I.R.E., Trans. on Electron Devices ED-7(3):185-186. July 1960.
- Schrader, E.E.

 A study of electron tube deterioration utilizing kinetic theory.

 (Radio Corporation of America. Electron Tube Division,

 Harrison, N.J. Quarterly Report 3; ... [ASTIA Document] AD

 235319). 1960. 87 p. [For the period: January 1, April 1,
 1960].
- PAR-40120 Vineze, Tibor, Comp.

 Reliability; A subject bibliography. (U.S. Dept. of the Air Force.

 Air University. Institute of Technology, Wright-Patterson Air

 Force Bass, Chio. Technical Report 61-1). February 1961. 60 p.

- PDL-40673 Koller, Walter F. (Minneapolis-Honeywell Regulator Company, Minneapolis, Minn.).

 Balacing thermal insulation and absorption in electronic packages. In Space/Aeronautics 35(6):129,131,133,135. June 1961.
- PDL-40838 Reve, John P. and J.W. Freeman.

 Effect of overheating on creep-rupture properties of M-252 allow.

 (U.S. Matienal Advisory Committee for Aeronautics. Technical
 Note 4-24). March 1958. 83 p.
- PDI-41445 King, J.C.
 Rusted components of material in storage. (U.S. Naval Civil
 Engineering Laboratory, Port Hueneme, Calif. Technical Note
 N-365; ... [ASTIA Document] AD 250628). October 1960. 112 p.
- PDL-41743 Mason, James D. (American Bosch Arma Corporation. Arma Division, Garden City, N.Y.).

 Temperature sensitivity in germanium transistors. In Aerospace Eng. 20(10):27,95. October 1961.
- PDL-42232 Deterioration of electrical insulation. In Engineering 192: 662-663. November 1961.
- R.C.A. Service Company. Government Service Dept., Camden, N.J.

 (K.B. Green and R.L. McLaughlin).

 Accelerated test techniques. (U.S. Rome Air Development Center.

 [Technical Report] 60-113; ... [ASTIA Document] AD 245502).

 May 1960. 244 p.
- PDL-42312 Atalla, M.M., A.R. Bray and R. Lindner.

 Stability of thermally oxidized silicon junctions in wet atmospheres. (Bell Telephone System, New York, N.Y. Technical Publications. Monograph 3733). In Inst. Elec. Engrs., Proc. 1068(Supplement 17):1130-1137. March 1966.
- PDI-42517 Dakin, Thomas W. (Westinghouse Electric Corporation, Pittsburgh, Pa. Research Laboratories).

 Electrical insulation deterioration. In Electro-Technol. 66(6): 123-130. December 1960.
- PDL-42590 Dinsmore, Oliver R., Jr. (U.S. Army Research Office, Durham, N.C.).

 Protection problems encountered in storing military equipment. In

 Materials Protection 1(1):66-68,70-73. January 1962.
- FDL-42604 Holden, Phil (Texas Instruments, Inc., Dallas, Texas).

 The "rate of change factor" in reliability. In Electro-Technol.
 69(1):53-55. January 1962.
- PDL-42724 Rychtera, Miroslav.

 [The influence of climate factors on electrical equipment in the tropics and electrical climatology]. In Slaboproudy Obzor.

 (Czech.) 20:499-505. 1959. In Czech with English Summary.